Computer Architecture Postdoctoral Scholar

As Moore Law's scaling slows in power and speed, energy has become the critical challenge. The emergence of multi-core, GPGPU computing, and other accelerator-based computing approaches are all signs if the imminent crisis. Heterogeneous computing approaches promise of 100-fold, but the ad hoc, irregular, and revocable introduction of large-scale heterogeneity, poses major challenges for software and computer science generally. Directly, to date there has been a fundamental divide between programmability (general purpose architecture) and accelerators (energy efficient VLSI architectures).

We are developing the 10x10 paradigm, a principled, systematic approach to heterogeneity in computer architecture. 10x10 exploits deep workload analysis to tame the power of VLSI customized design and create new architectures that are both programmable and energy-efficient, appropriate for future data centers of millions of processors and future billions of mobile devices. The key idea is to take a broad systematic approach to accelerators, partitioning workloads into a large number of "bins" (e.g. 10) each of which correspond to a modest fraction of the overall workload (a tenth, perhaps). With narrow focus, energy efficiency comparable to hardwired accelerators can be achieved, while preserving general-purpose computational capability and programmability. These new 10x10 federated heterogeneous architectures will represent stable targets for new software stacks that deliver both energy-efficient performance and robust, portable software for future generations of systems.

This Postdoctoral scholar position provides the opportunity to work with leading computer scientists in LSSG, the University of Chicago, Argonne National Laboratory, the University of Illinois and the San Diego Supercomputing Center, as well as the broader community of DARPA's Perfect program The position will involve research across computer architecture (instruction sets, processor customization, memory hierarchies), and use of CAD tool chain flows to thoroughly evaluate energy and performance of resulting designs. Software-driven emulation using large workloads and detailed simulation will be used based on the best advanced circuit and process models for NTV and sub 10nm devices.

We are recruiting a talented, ambitious postdoctoral scholar with the energy and creativity to pioneer a new generation of microprocessor architectures.

Desired qualifications:

- exceptional intelligence, creativity, and drive to make high impact contributions
- strong research expertise in computer architecture: design and implementation
- experience with ECAD software, design flows, and emulation and simulation tools
- the energy to create and prove out radical new architecture ideas with breakthrough impact
- intellectual curiosity to solve fundamental academic research problems
- strong communication and teamwork skills

A recent PhD (or other doctoral degree) in Computer Science or related discipline is required. This positions is available as early as Fall 2012; additional opportunities may arise throughout the year. Postdoctoral Scholar appointments are typically renewable on annual basis. This position

will be located at the University of Chicago. For more information, contact Professor Andrew A. Chien, achien@cs.uchicago.edu, 1100 East 58th Street, Chicago, IL 60637

The Large-Scale Systems Group (LSSG) Established in July 2011 by Andrew Chien, the Large-scale Systems Group is exploring critical systems research questions for robust, scalable systems which pervade the internet, high performance, and cloud computing. Achieving extraordinary scale poses difficult challenges; our interests include programming abstractions, system software and networking, architecture, and applications. Current projects include:

- *10x10 – Taming Heterogeneity for Energy-Efficient, General-Purpose Computing* In the waning days of Moore Law's, energy is the key challenge. Heterogeneity promises 100-fold improvements, but its introduction in ad hoc fashion, poses major challenges for software and algorithms generally. The 10x10 paradigm is a principled, systematic approach to heterogeneous architectures, creating stable targets for new software stacks that deliver both energy-efficient performance and robust, portable software for future systems.
- *GVR -- Global-View Resilience* Future internet, high-performance computing, and cloud systems will have billion-fold concurrency built from millions of "less reliable" components. In short, sustaining massive concurrency with high reliability – and for fine-grained computations is a unsolved, critical challenge. The GVR project is creating new programming abstractions that enable computation to maintain high concurrency; flexible, proportional resilience under programmer control. We are also developing a raft of efficient implementation techniques combining scale, innovative storage hierarchies, and rich error detection and recovery. *(part of EASE -- Easy Exabyte Computing)*
- *Blockus – Big Data computing with Small Memories* Today's big data computing world is built on map-reduce, processor-memory-disk slices, and scales reliably to petabyte data sizes. Its two major weaknesses are cost and programming inflexibility. In Blockus, we are exploring the use of new storage-class memories with intelligent storage-hierarchy management to achieve dramatically better cost-performance and programming flexibility for big data computations. *(part of EASE -- Easy Exabyte Computing)*

See https://sites.google.com/site/uchicagolssg/lssg LSSG gratefully acknowledges support from the DOE Office of Science, Defense Advanced Research Projects Administration (DARPA), and National Science Foundation.

The University of Chicago The University of Chicago (www.uchicago.edu) is one of the world's great intellectual communities. Founded in 1890 with an extraordinary donation by John D. Rockefeller it has grown to over 2,000 faculty and 15,000 students. Founded with a focus on research excellence, the University continues this tradition with numerous Nobel Prize and other notable awards and with two-thirds of the student population in graduate programs. The University of Chicago is consistently ranked in the top dozen universities globally with top-ranked programs in sciences, humanities, and professional schools (business, medicine, and law).

The Department of Computer Science (cs.uchicago.edu) is the hub of a large, diverse computing community of two hundred researchers focused on advancing foundations of computing and driving its most advanced applications. Long distinguished in theoretical computer science and artificial intelligence, the Department is building a strong Systems research group. This closely-knit community includes the Computation Institute, the Toyota Technological Institute, and Argonne's Mathematics and Computer Science Division. See http://systems.cs.uchicago.edu

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